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Aviation in Europe – Innovating for Growth

The 7th European Aeronautics Days

L O N D O N

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Clean Sky Technology Evaluator

as part of an European Assessment Capability

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Overview

- Session background: tool suites demonstrating the European Assessment Capabilities
- Clean Sky Technology Evaluator
  - What is it and how does it work?
  - Changes wrt. Clean Sky 2
- Resume wrt. Session background: how far are we wrt. improved Assessment Capabilities?

Assessment purposes, objects, reqs.

Potential applications of aviation related model suites creating an EU assessment capability

Purposes	Assessment objects	Assessment levels		
		mission	Airport	global
identifying chances to reach all goals of ACARE/Flightpath 2050	vehicle and procedures trend scenarios	required	required	required
identifying success level wrt. ACARE 2020 environmental goals	technology innovation wrt. vehicles/ components/life cycles/ ATM procedures	V	V	V
Committee on Aviation Environmental Protection (CAEP)	aircraft & fleet technology related regulations	V	V	V
EU policy evaluation and scenario assessments	fleet technology & policy scenarios assessing impacts of measures	V	V	V
success level wrt. ACARE 2020 and Flightpath 2050 environmental goals	technology innovation wrt. vehicles/ components/life cycles/ATM procedures + single technology & mobility innovations	V	V	V
SESAR and success level wrt. ATM goals	ATM technology and operation scenarios	V	V	V
US policy evaluation and environmental & economic impacts	technology innovation wrt. Vehicles/components/life cycles/ATM procedures + single technology	V	V	V

Remark: ICAO has additonal performance indicators (e.g. safety, security), which are not covered here!

Clean Sky Technology Evaluator

- What is it and how does it work?
- Enhancements as part of Clean Sky 2

Innovation takes off

ACARE SRA goals for 2020 and Clean Sky 1 Technology domains

Clean Sky 1 Technology Evaluator consortium

TE has 17 core participants:

- 5 Members from Research
  - CIRA (Italy)
  - Cranfield University (United Kingdom)
  - DLR (Germany) – Technical Lead
  - NLR (Netherlands)
  - ONERA (France)

- All 12 Clean Sky ITD leaders (Airbus, Saab, Alenia-Aermacchi, EADS-CASA, Dassault, FHG, EC, AW, RR, Safran, Thales (Administrative Lead), Liebherr)

TE working with the ITDs for the Assessments

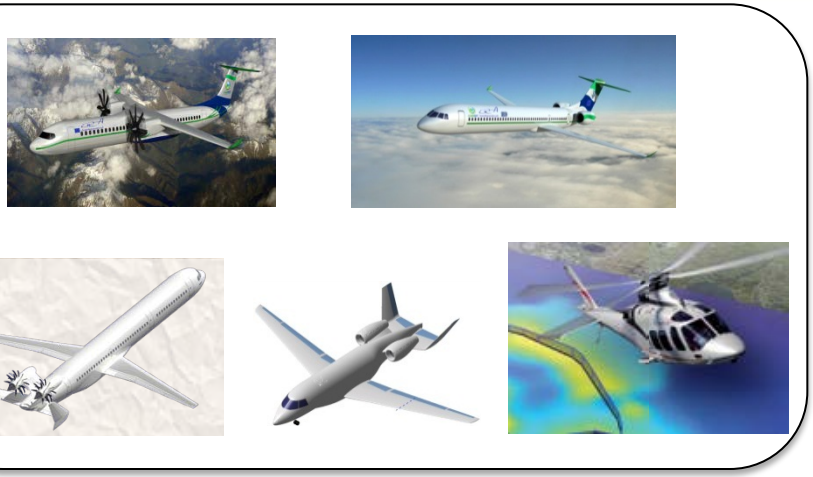
Transverse ITDs

- ECO
- SAGE
- SGO

Vehicle ITDs

- SFWA
- GRC
- GRA

New aircraft concepts



Technology studies

TRL evaluation / progress Integration into major system level

Technology Demonstrators

Performance models for new aircraft concepts

TE Assessment of Environmental benefits versus ACARE SRA goals

Clean Sky 1 Setup – ITDs and TE

Technology Evaluator

DLR & Thales

Technology Description

Eco-Design

Dassault & Fraunhofer

Smart Fixed Wing Aircraft

Airbus & SAAB

Green Regional Aircraft

Alenia & CASA

Green Rotorcraft

Eurocopter & AgustaWestland

Sustainable and Green Engines

Rolls-Royce & Safran

Systems for Green Operations

Thales & Liebherr

TECHNOLOGIES & DEMONSTRATORS

TECHNOLOGIES & DEMONSTRATORS

Clean Sky

Clean Sky 1 TE general scope and approach

TE has the function TO MONITOR PROGRESS and TO ASSESS environmental impacts (noise, emissions) of new technologies developed in Clean Sky's ITDs in order TO SUPPORT FEEDBACK via

- Environmental impact assessments at
  - vehicle level along a mission (for aircraft and rotorcraft) to quantify i.e. reduction of noise and emissions, and the success level wrt. ACARE environmental goals;
  - airport level to check the benefits in practice, wrt. to noise, emissions and capacity;
  - global level to quantify potentials on a global scale.
- Trade-off studies (according to ITDs needs)
- TE Information System enabling to access results of assessments and track developments

NB: Beside TE, the industrial platforms (ITDs) track TRL levels.

Clean Sky

Three assessment levels – Activities & Approach

Mission level

Comparison of impacts (on noise & emissions) stemming from 2000 aircraft / rotorcraft with 2020 Clean Sky aircraft / rotorcraft in representative reference missions;

Difficulty: partly no comparable 2000 r/c available

Solution: selection & elaboration of 2000 counterparts

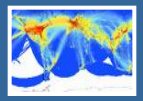
Airport level

Comparison of impacts (on noise & emissions & capacity) stemming from 2000 fleet with 2020 Clean Sky fleet on airports (one typical day) for a 2020 traffic scenario

Difficulty: only about 80% of 2000 fleet survives until 2020

Solution: application at a mix of airports

ATS level



Comparison of impacts (on noise & emissions) stemming from 2000 global fleet and movements with 2020 fleet with Clean Sky technologies for a 2020 traffic scenario

Difficulty: limited market penetration of CS tech in 2020 and unpredictable difference between natural and CS evolution

Solution: 3-point assessment with focus on potentials

Clean Sky

Three assessment levels - Outputs & Metrics

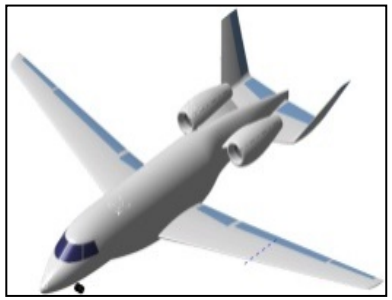
TE Level	Output	Example Metric
Mission level	• Carpet noise time stamped grids • Engine emissions for specific flight phases • Engine emissions over a complete mission • Life cycle assessment	• Acoustic levels • Single dB values • Mass of emissions
Airport level	• Noise contours • Population impacted by noise • Capacity and throughput • Fuel burn along take-off and landing segments • Local air quality at airport	• Lden and Lnight • Surface area of noise contours • Number of people exposed to noise • Mass of emissions
ATS level	• Fleet noise impact at major European airports • Emission inventories • Life cycle assessment	• Lden and Lnight • Surface area of noise contour • Number of people exposed to noise • Total mass of emissions

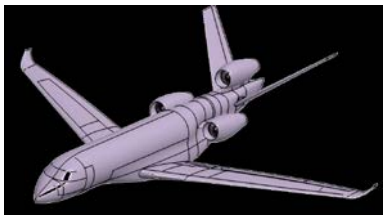
Level of success towards ACARE / Clean Sky goals

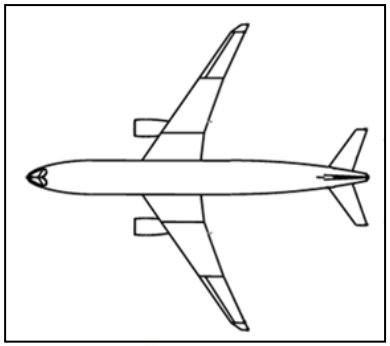
Clean Sky

Clean Sky aircraft technologies

Bizjet aircraft	
Low Sweep Bizjet (LSBJ) aircraft	Natural laminar wing, U Tail for noise optimisation
	2020 Entry in Service technology engines
High Sweep Bizjet (HSBJ) aircraft	Natural laminar flow wing
	Innovative 3-engine afterbody (2020 EIS technology engines)
Regional aircraft	
Turbo Prop (TP) 90 aircraft	Advanced Composite Materials and SHM
	Low Noise Landing Gear and high efficiency high lift devices
	Electrical Environmental Control System
Geared Turbo Fan (GTF) 130 aircraft	Advanced Composite Materials and SHM
	Natural Laminar Flow Wing
	Advanced Geared Turbofan
Mainliner aircraft	
Short and Medium Range (SMR) aircraft	Natural Laminar Flow wing
	Contra-Rotative Open Rotor (CROR) engine
	SGO technologies
Long Range (LR) aircraft	Advanced three shaft Turbo Fan engine
	SGO technologies



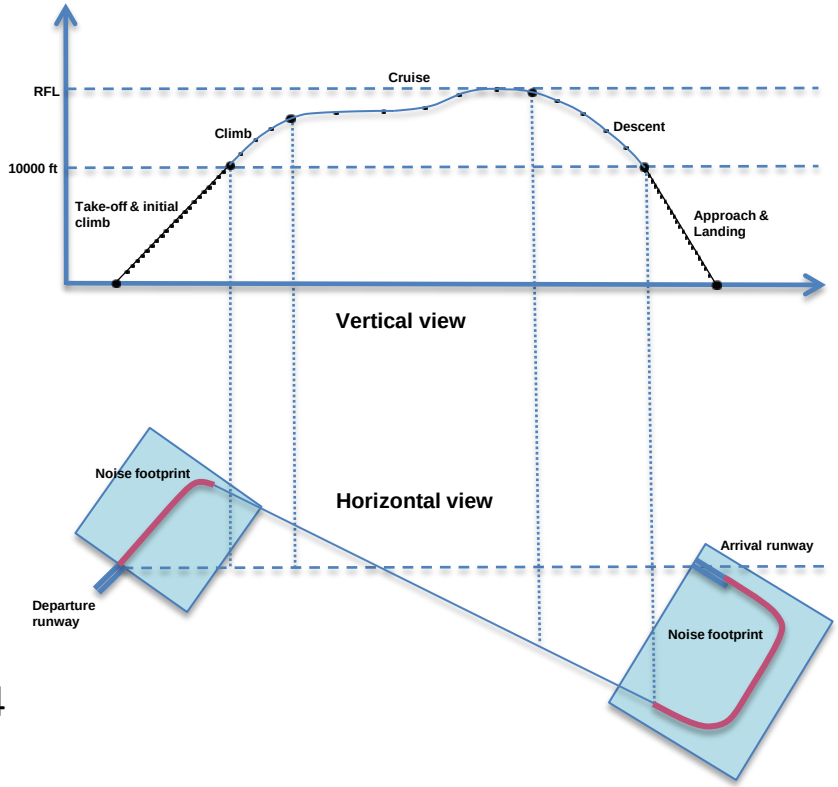




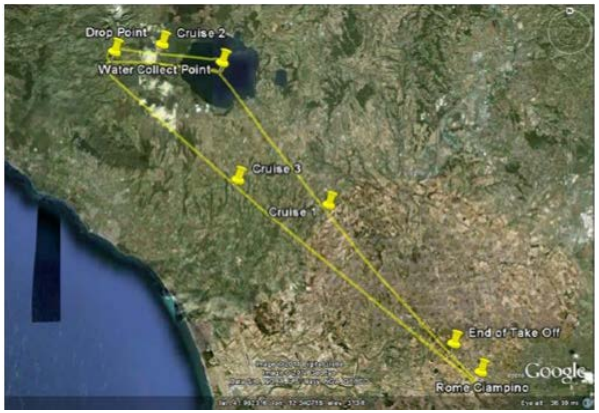
Clean Sky

Examples of Virtual Missions “flown”

Example of a generic aircraft mission



Rotorcraft missions (fire suppression, Search And Rescue)



TE Assessment provisional Results [2]

Clean Sky concept aircraft	Noise area reduction (take-off)	CO_2[1]	NO_X[1]
Low Sweep Biz-Jet (innovative empennage)	-58%	-33%	-34%
High Sweep Biz-jet	-10%	-19%	-26%
TP 90 Regional - Turbo-prop	-81%	-20%	-42%
GTF 130 Regional - Geared Turbo-fan	-57%	-27%	-35%
Short-medium range - Open rotor engine	-55%	-40%	-44%
Long Range - 3 shaft Advanced Turbo-fan	-79%	-19%	-50%
Clean Sky concept rotorcraft	**Noise area reduction (total mission)**	**CO_2**	**NO_X**
Single Engine Light Rotorcraft	-25%	-20%	-58%
Twin Engine Light Rotorcraft	-53%	-27%	-75%
Twin Engine Heavy Rotorcraft	N/A	-21%	-55%
Twin Engine Medium Rotorcraft	-23%	-10%	-36%

[1] results for emissions are normalised for size / capacity effects [emissions per available seat]

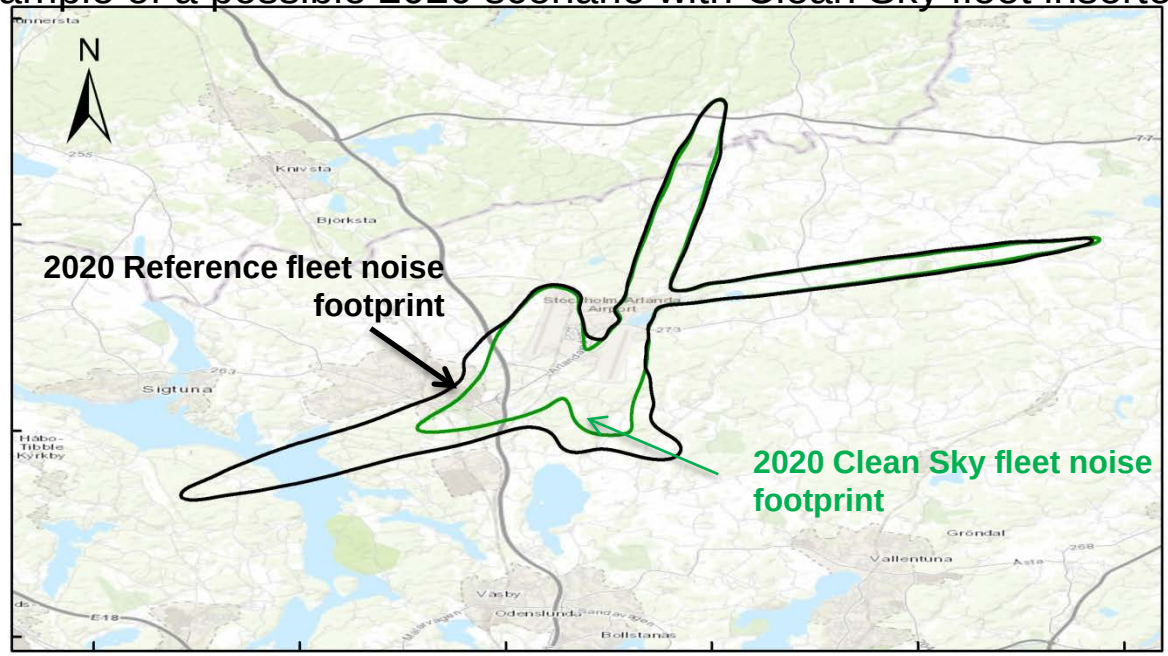
[2] results are still provisional, final results will be produced in the 2016 final assessment

Clean Sky

TE Assessment provisional Results: Airport level [2]

Comparison of 55 dBA Lden contours

Example of a possible 2020 scenario with Clean Sky fleet inserted



- **36% noise area surface reduction**
- **31% reduction of noise exposed people living around the airport**

Clean Sky

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TE Assessment provisional Results: ATS level, comparison between 2020 Clean Sky and 2020 reference fleet [2]

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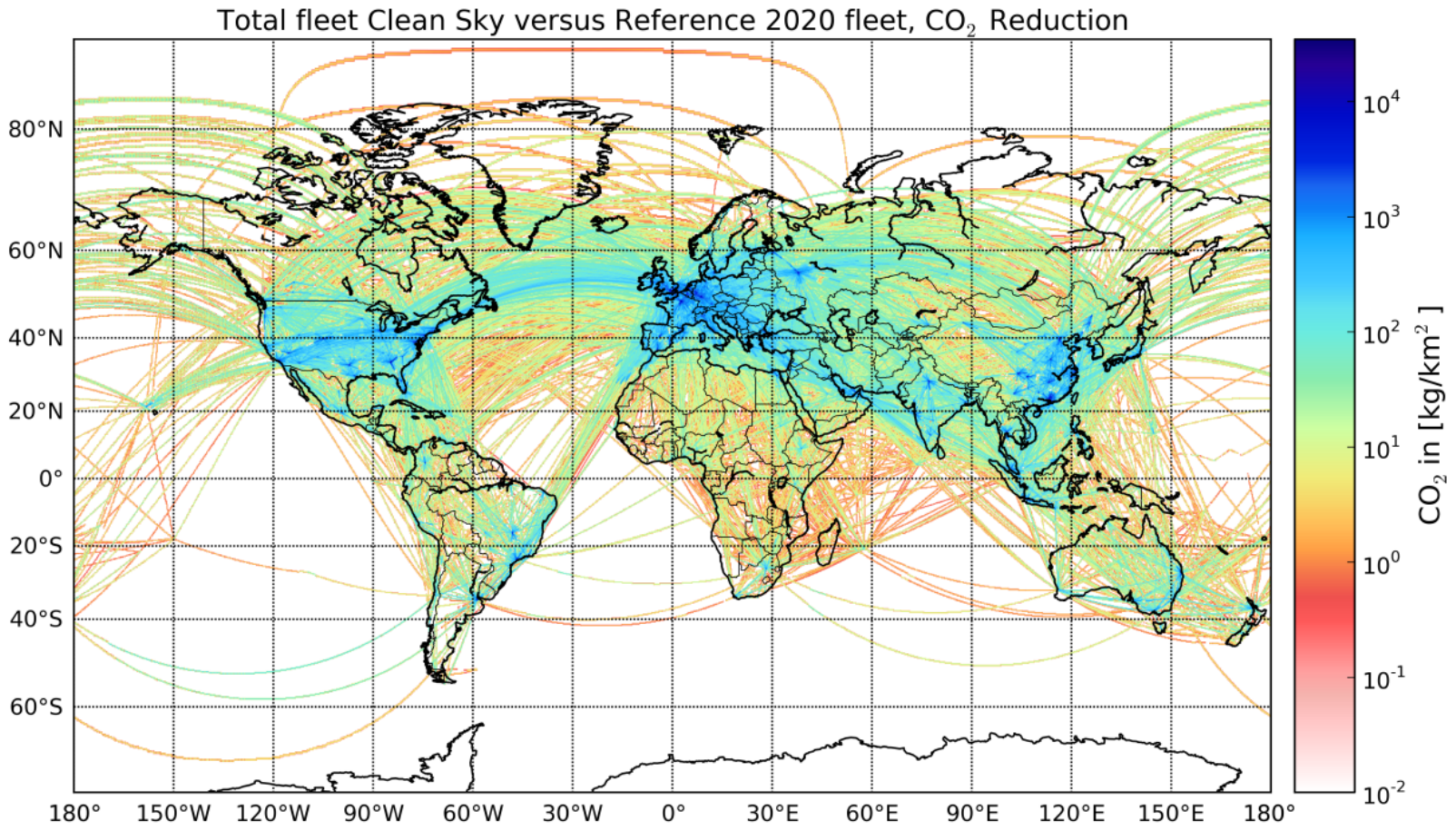
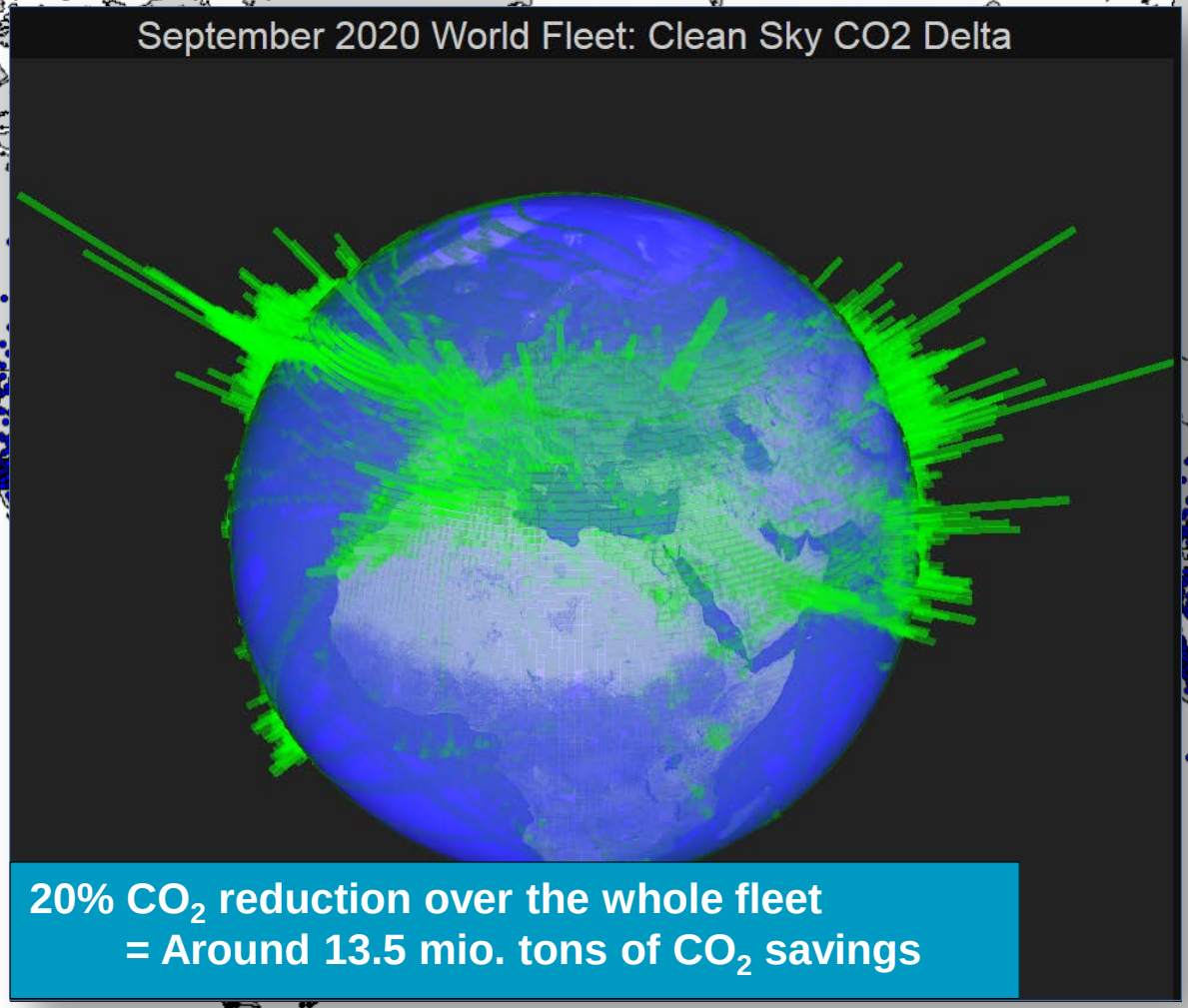


20% CO_2 reduction over the whole fleet
= Around 13.5 mio. tons of CO_2 savings

TE Assessment provisional Results: ATS level, comparison between 2020 Clean Sky and 2020 reference fleet [2]



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Technology Evaluator – CS1 => CS2

Potential applications of aviation related model suites creating an EU assessment capability

Tool suites	Assessment results / impacts		
	Environment	Economy	Mobility
Clean Sky 1 Technology Evaluator run by 5 REs	Noise CO2, NOx		

Aim for the TE in Clean Sky 2 is to extend the impact assessments wrt. the 6 ACARE High Level Target Concepts. This will be done via additional impact assessments regarding the aviation footprint, considering also Economy and Mobility.

Clean Sky 2 Technology Evaluator run by REs	Noise & annoyance CO2/climate? NOx	employment + GDP (EU & national)	ACARE 4h goal incl. travel time savings and connectivity; future airport capacity constraints; r/c productivity (payload)

Remark: It is yet not defined, if climate impact assessments will be performed

Tool Suite selection & impacts covered

Potential applications of aviation related model suites creating an EU assessment capability

Tool suites	Assessment results / impacts		
	Environment	Economy	Mobility
ACARE/Flightpath Tool Suite	Noise & annoyance CO2, NOx, Life Cycle	(innovation) time to market	primary delays at airports; terminal/travel time; 4 h goal
Clean Sky 1 Technology Evaluator run by 5 REs	Noise CO2, NOx		
IMPACT run by EUROCONTROL	Noise & annoyance CO2, NOx		
TEAM_Play run by 17 REs	Noise & annoyance CO2/Climate NOx/LAQ	employment + GDP (EU & national); not yet prepared for airport & surrounding	prepared for: ACARE 4h goal
Clean Sky 2 Technology Evaluator run by REs	Noise & annoyance CO2/climate? NOx	employment + GDP (EU & national)	ACARE 4h goal incl. travel time savings and connectivity; future airport capacity constraints; r/c productivity (payload)
IMPACT + ? run by EUROCONTROL	CO2, NOx, Noise & annoyance	Airport and ATM capacity & cost effectiveness (ACE)	primary delays at airport and secondary at network level
US Tool Suite run by FAA et al.	Noise & annoyance CO2/Climate NOx/LAQ	e.g. health impacts; house value change around airports	primary delays at airport and secondary at network level

Thank you for your attention!

Questions?

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Further Information on Clean Sky:

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ICAO KPAs

ICAO Global ATM Concept Plan (ATMCP) Doc 9854

- 11 Key Performance Areas (KPAs) defined for ATM